HP Turbine Dense Pack Modifications
Operating Options and Economic and Environmental Analysis

		Unit Operation			Economics				Environmental			
Option	Description	Station Max Gross Load	Station Net Heat Rate (BTU/KWH)	Station Fuel Consumption (Tons/Year)	Total Capital Cost	Benefit Per Year	Payback Period (Years)	Benefit/Cost Ratio	NOx Emissions per Year (Tons)	SO2 Emissions per Year (Tons)	Environmental Assessment	Comments
	Current Operation	1750 MW	9500	5,268,249	NA	NA	NA	NA	26109	2984	Current Emissions limits are 0.5 lbs/MBTU of NOx and 0.15 Lbs/MBTU of SO2. Both on rolling 30 day average basis.	Current NOx emissions rate is 0.42 lbs/MBTU and SO2 is 0.048 lbs/MBTU
1	Maintain the same historical maximum load with improved heat rate.	⇔ Same	⇩ -214	⇩ -118,536	$9,400,000	$4,267,282	0.96	11.67	⇩ -587	⇩ -67	Operating in this manner should not trigger a New Source Review (NSR) or Prevention of Significant Deterioration (PSD) review.	There should be no change in NOx and SO2 emissions rate. Total tons per year reductions are from decreased coal burn.
2	Maintain the same historical steam flow and increase turbine/generator output. (Note 6)	⇧ 40 MW	⇩ -214	⇔ Same	$9,600,000	$15,137,280	0.28	39.46	⇔ Same	⇔ Same	Since the NOx and SO2 emissions should not change, increasing load should not mandate a NSR or PSD review. May be difficult to prove as it varies from year to year naturally.	There should be no change in NOx and SO2 emissions rate.
3	Install additional plant improvements to increase boiler and other systems capacity. Install moderate NOx reduction equipment (Note 7).	⇧ 100 MW	⇩ -214	⇧ 310,224	$36,400,000	$35,784,705	0.87	12.89	⇩ -6362	⇩ -680	Permitting with moderate NOx control should not be difficult. Current laws would require 0.46 LBS/MBTU limit in the future. Plans for more aggressive reduction (IE: SCR's) should not be made at this time.	Assumes NOx emissions will lower to 0.3 Lbs/MBTU and SO2 emissions will lower to 0.035 Lbs/MBTU (See Note 5)

Item	General Assumptions	
1	Present Value Annuity Factor (P/A, 6.35 %, 20 years):	11.2
2	Hours of equivalent operation/year (8760X 0.9 Cap. Factor):	7884
3	Cost of Fuel ($/Ton):	$36
4	Cost of replacement energy ($/MWH)	$48
5	Avoided maintenance cost for the station (Note 1):	$5,304,000
6	High pressure turbine section retrofit:	$9,400,000
7	Cost of additional plant improvements (Note 2):	$12,000,000
8	Cost of moderate NOx control equipment (SNCR):	$15,000,000
9	Operating cost per year for SNCR (Note 4):	$2,058,495
10	Coal (BTU/LB)	11,800
11	Urea (SNCR Reagent) Utilization per Ton NOx removed (Tons)	1
12	Cost of Urea per Ton (Note 3)	$300

Analysis for Option 1	
Turbine Efficiency Increase (guaranteed by supplier) =	2.25%
Boiler Heat Input Reduction = Proportional to Turbine Efficiency Increase =	2.25%
Net Heat Rate Reduction = 2.25%(9500 BTU/KWH) =BTU/KWH	214
Reduced Fuel = (Heat Rate Reduction)(Station Net Load)(Equiv.Hrs)/(Coal BTU/Lb)(2000 Lbs/Ton) = (Tons)	118,536
Benefit per Year = (Reduced Fuel)(Cost of Fuel) = $	$4,267,282
Payback Period = (Capital Costs - Avoided Costs) /Benefit per Year = Years	0.96
Benefit to Cost Ratio = (Benefit per Year)(PV Annuity Factor)/(Capital Costs - Avoided Costs) =	11.67

Analysis for Option 2	
Benefit per Year = (Increased Generation)(Equiv. Hrs.) (Cost of Replacement Energy) = $	$15,137,280
Payback Period = (Capital Costs - Avoided Costs) /Benefit per Year = Years	0.28
Benefit to Cost Ratio = (Benefit per Year)(PV Annuity Factor)/(Capital Costs - Avoided Costs) =	39.46

Analysis for Option 3	
Benefit per Year = (Increased Generation)(Equiv. Hrs.) (Cost of Replacement Energy) - Operating Cost/Year = $	$35,784,705
Payback Period = (Capital Costs - Avoided Costs) /Benefit per Year = Years	0.87
Benefit to Cost Ratio = (Benefit per Year)(PV Annuity Factor)/(Capital Costs-Avoided Costs) =	12.89
Increased Fuel = (Decreased Heat Rate)(Increased Net Load)(Equiv.Hrs)/(Coal BTU/Lb)(2000 Lbs/Ton) = (Tons)	310,224

Notes

Note 1 - Avoided maintenance cost equals the normal overhaul cost for the turbine HP section plus the avoided outage extension of 3 days to refurbish the HP nozzle block.

Note 2 - Cost of additional plant improvements are the projects necessary to increase the capacity of all other plant systems to handle the increased load. This includes the cooling towers, main transformer, generator cooling and other systems.

Note 3 - Cost of Urea is based on $0.75 per gallon for a 50% liquid solution.

Note 4 - Operating cost for SNCR includes 1% of the capital cost per year for Maintenance.

Note 5 - SO2 emissions will decrease by installation of a device to increase scrubber removal efficiency. The device eliminates the "sneakage" of flue gas around the module walls thus improving removal efficiency.

Note 6 - Capital cost includes an extra $200,000 for minor modifications to main transformer and isophase duct to handle increased load.

Note 7 - For this economic analysis, moderate NOx reduction technology is assumed to be Selective Non-Catalytic Reduction (SNCR) because it is well proven. Other technologies such as ultra-low NOx burners will be evaluated before the final decision is made.